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SEASONAL HISTORY, HABITS, AND IMMATURE STAGES OF *BELONOCHILUS NUMENIUS* (HEMIPTERA: LYGAEIDAE)

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Abstract.—The seasonal history of the orsilline lygaeid *Belonochilus numenius* (Say) was studied in southcentral Pennsylvania during 1976–81. Eggs overwintered in fruiting heads of London plane, *Platanus* × *acerifolia* (Ait.) Willd., and began to hatch in early to mid-April; nymphs developed in old fruits persisting on the trees or in fallen fruits beneath the hosts. Adults of the first generation began to appear in late May, those of the second generation during early July. A third (and perhaps fourth) generation was produced during August–September. Nymphal development in the laboratory required an average of 28.8 days at 20° C. The egg is described and the fifth instar is described and illustrated; brief descriptions and comparative measurements are provided for the other four instars.

Belonochilus numenius (Say), originally described in *Lygaeus* in 1831 and known from the New England states south to Louisiana and west to California and Mexico, is the only North American member of the genus (Slater, 1964). Before its food plant was known, this orsilline lygaeid was considered "very" or "extremely rare" (Uhler, 1871, 1878). Van Duzee (1894) recorded *B. numenius* from goldenrod, but the actual host was not discovered until Heidemann (1902) found nymphs of all stages on leaves of sycamore or American plane trees (*Platanus occidentalis* L.). Additional collecting allowed Heidemann to associate nymphs with the sycamore fruits. In California, Van Duzee (1914) also recorded nymphs from sycamore fruits, and in the laboratory Ashlock (1967) observed nymphs and adults feeding on seeds of sycamore. Heidemann (1911) described and figured the egg and reported that it is this stage that overwinters, rather than adults as he earlier suggested (Heidemann, 1902). Blatchley (1926), having collected an adult under a log in late April, suggested that adults overwinter in the latitude of Indiana. Torre-Bueno (1946) stated that adults hibernate under bark, probably basing his opinion on observations he had made in Arizona (Torre-Bueno, 1940). In Mexico (Tamaulipas) adults have been taken under bark during autumn (U.S. National Museum collection).

Except for Heidemann's (1902, 1911) fragmentary, somewhat confusing sketch of life history, *B. numenius* has remained largely unstudied; sycamore and the western *Platanus racemosa* Nutt. and *P. wrighti* S. Wats. have been merely confirmed as the principal hosts (Torre-Bueno, 1940, 1946). Apparently this lygaeid develops occasionally on other plants. In Missouri, Froeschner (1944) observed nymphs on giant ragweed, *Ambrosia trifida* L., and on hackberry, *Celtis occiden-*

talis L.; nymphs and teneral adults have been collected in Maryland on willow, *Salix* sp. (USNM).

Here, I summarize the seasonal history of populations studied on London plane, *Platanus* × *acerifolia* (Ait.) Willd., in southcentral Pennsylvania and report developmental times for the nymphal stages based on laboratory rearing. The egg is described and the fifth instar described and illustrated; diagnoses are given for the second through fourth instars.

Methods

Seasonal history at Harrisburg, Pennsylvania, was studied by collecting *Belonochilus numenius* from a street planting of mature London plane trees. Beginning April 1, 1978, the pistillate heads or fruits, both fallen and those persisting on trees, were collected and examined in the laboratory for the hatching of overwintered eggs. Once eggs had begun to hatch (about April 10), fruits were collected every 7–10 days through mid-July and every 2–4 weeks through early November. Under a stereoscopic microscope, all stages of the lygaeid present were counted and recorded (almost always 10 individuals and usually more). To supplement the data on seasonality of *B. numenius* obtained from dissecting sycamore fruits in 1978, a less time-consuming technique was used in 1981. From 1–5 fruits were collected weekly from late April to early June and biweekly from late June to early September, placed in a Berlese funnel, and all nymphs (adults were counted in the field and removed) falling in the container beneath were sorted to stage and counted. The number of nymphs obtained varied from 0 to more than 50 (average 15/sample). Collections made irregularly during 1976–77 and 1979–80 provided additional information on early- and late-season activity.

In the laboratory developmental times were determined by rearing nymphs at 20° C with natural photoperiod. Nymphs were assigned numbers, placed with a water source in individual petri dishes containing several coriaceous nutlets from fruiting heads of London plane, and checked daily for ecdysis. Owing to a high rate of mortality in the laboratory cultures, the developmental times reported are based on the determination of instars for field-collected, first generation nymphs of various stages.

Biology

Seasonal history.—Eggs overwintered mainly within fallen fruiting heads of London plane; only a few fruits remained on the trees during winter 1977–78. Eggs usually were inserted singly between nutlets, flush with the fruit surface or slightly protruding (Fig. 1), or in loose clusters of 2–10 in cavities near the base of the peduncle. Overwintered eggs began to hatch during April 10–11, 1978, and continued to hatch until early May (in 1979 first instars were common on fallen fruits by April 5). Early instars fed deep within the heads and could be seen clustered around the core after nutlets had been removed.

In the May 1, 1978, sample, second through fourth instars were found in nearly equal numbers. Fifth instars were observed by May 8, and the first adults appeared in the sample of May 20. This first generation developed beneath host trees on fallen fruits that had broken into clusters of nutlets. A smaller percentage of the population developed on the few heads of the previous season that remained on host trees.

Fig. 1. Egg of *B. numenius* (at arrow) in fruiting head of London plane, *Platanus × acerifolia.*

First generation adults became common during the last week of May, and soon eggs were deposited on the small, green current-season fruits. Females also oviposited in the few old fruits remaining on the trees, but no eggs were found in fallen fruiting heads. First instars of the second generation were present by early June along with fourth and fifth instars of the first brood. Second generation nymphs developed mainly on immature fruits of the current season and fed on the surface or at the base of peduncles since they could not penetrate the interior of these harder, more compact fruits. The overlapping of generations became increasingly evident; by June 20 all nymphal stages of the second generation were present, plus a few first generation adults, which continued to mate and oviposit.

On July 7, 1978, fourth and fifth instars and teneral adults were observed, with first generation adults still present. Although the overlapping of broods made it more difficult to interpret phenology during the remainder of the season, an increase in numbers of adults in the early August sample, coupled with laboratory data showing that at 20° C the nymphal period requires an average of 28.8 days (Table 1), indicated the development of a third generation. A fourth generation may have been completed during the remainder of August and into late September–early October, but the infrequency of late-season sampling precluded documentation of a fourth brood. Although mating pairs were found on fruiting heads as late as early November, early instars were absent in samples taken during late September through October 1978. This suggests that eggs deposited by third or fourth generation females represented the overwintering stage. At the sample site, adults have been taken under bark of London plane trees during November,

Table 1. Duration (in days) of the nymphal stadia of *B. numenius* reared at 20° C under natural photoperiod.

Stage	No. individuals	Duration		
		Range	Mean ± SE	Cumulative mean age
Nymphal stadia				
1st	12	4–8	6.2 ± 0.32	6.2
2nd	13	4–7	4.7 ± 0.29	10.9
3rd	15	3–8	4.4 ± 0.32	15.3
4th	16	4–9	5.2 ± 0.32	20.5
5th	7	6–10	8.3 ± 0.47	28.8

but only eggs have been found to survive until spring. Adults, however, may overwinter in more southern latitudes.

Sampling in 1981 gave a similar picture of early-season phenology. Adults of the first generation first appeared in the May 20 sample, first instars of the second generation were numerous on June 8 (30 of 36 nymphs sorted), and first instars of a third generation appeared in the August 5 sample. No nymphs were obtained in an early September collection, but a single first instar obtained from the early October sample may have indicated the presence of a fourth (and perhaps partial) generation.

Belonochilus numenius thus is a multivoltine lygaeid that feeds on immature and mature fruits of *Platanus* spp., with the elongated labium an adaptation for this specialized mode of feeding. Although in some years the first generation develops mainly on fallen fruits and scattered clusters of nutlets from disintegrated heads, this species should be considered an arboreal rather than terrestrial seed predator. Brachypterous morphs, so common in populations of litter-inhabiting lygaeids (Slater, 1977), are absent. Adults disperse actively, with those of the first generation moving from fallen fruits to host trees where they mate and oviposit on immature heads or old fruits from the previous season.

Descriptions

Egg (n = 10).—Length 1.34–1.56 mm, $\bar{x}$ = 1.44; width 0.28–0.32 mm, $\bar{x}$ = 0.30. Elongate, slightly tapering toward posterior pole; pale yellow when deposited, becoming brownish before eclosion, smooth, hexagonal sculpturing faint. Aeromicropyles 5–7 encircling anterior pole, stalked and bearing inward-directed cup-like processes (see Heidemann, 1911, Pl. 10, Fig. 1).

Fifth instar (in alcohol, n = 9) (Fig. 2).—Oblong-oval, widest across middle of abdomen, length 4.58–6.08 mm, $\bar{x}$ = 5.38; general color testaceous, marked with reddish brown and fuscous, intensity of darker markings variable. Head porrect, nondeclivent, longer than wide, tylus extending nearly to middle of antennal segment II, length 1.20 mm, width 1.04 mm, interocular space 0.64 mm; fuscous stripes on either side of midline from near apex of tylus to base, reddish to fuscous lateral stripes visible from antennal bases to base of head; labium elongate, extending to middle or base of abdomen, length of segments variable, I, 0.90–1.20 mm; II, 0.90–1.34; III, 1.10–1.52; IV, 0.64–0.90; antenna testaceous, segment IV stout, reddish brown or fuscous, length of segments, I, 0.26 mm; II, 0.70; III,

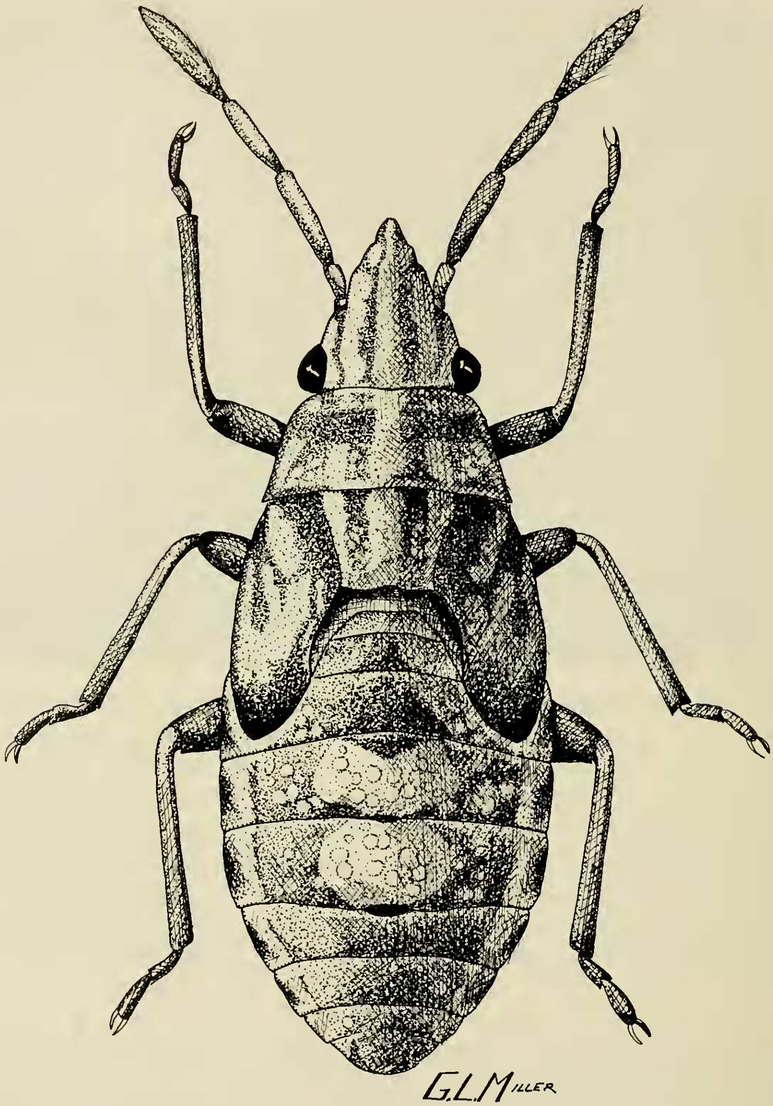

Fig. 2. *B. numenius,* fifth instar.

0.56; IV, 0.66, total antennal length 2.18 mm. Pronotum trapeziform, anterior margin shallowly concave, truncate posteriorly, lateral margins carinate, length 0.72 mm, width 1.56 mm; testaceous, median line pale, bordered by fuscous stripes, sometimes an additional fuscous stripe visible midway between midline and edge, lateral edge pale, bordered by narrow fuscous line, calli irregularly mottled with brown; scutellum testaceous, margined with fuscous, median line pale; wing pads testaceous, margins fuscous and basal half mottled with fuscous, apices nearly reaching posterior margin of abdominal tergite III. Abdominal tergites reddish brown to fuscous (tergite II sometimes testaceous), broken by numerous pale spots, marginal areas of segments testaceous; dorsal abdominal scent gland openings between tergites 4–5 and 5–6, rims thin, darkened, broad pale areas visible anterior to scent gland openings (appearing darker in some specimens); venter uniformly testaceous; a reddish-brown to fuscous stripe along pleural areas of thorax, broken by paler spots along edge of abdomen. Legs pale testaceous, sides of femora sometimes with faint brown spots, fore femora incrassate with short, blunt spine near apex.

Fourth instar (in alcohol, n = 5).—Similar in form and color to 5th instar. Dark markings on head, pronotum, and wing pads less intense; large, clearly defined red areas anterior to abdominal scent gland openings in most specimens; wing pads reaching abdominal segment I.

Length, 3.60–4.20 mm, $\bar{x}$ = 3.89. Head, length 0.80–0.84 mm, $\bar{x}$ = 0.81; width 0.66–0.70 mm, $\bar{x}$ = 0.68; interocular space 0.46–0.52 mm, $\bar{x}$ = 0.49. Protergal length 0.42–0.44 mm, $\bar{x}$ = 0.43; humeral width 0.82–0.88, $\bar{x}$ = 0.86. Antennal lengths I, 0.16 mm; II, 0.32–0.34; III, 0.24–0.28; IV, 0.42–0.44. Labial lengths I, 0.56–0.64 mm; II, 0.58–0.68; III, 0.60–0.84; IV, 0.44–0.52.

Third instar (in alcohol, n = 5).—Similar in form and color to 4th instar. Dark markings on head generally less intense; mesothoracic wing pads distinct, slightly overlapping metanotum. Note: labium in one specimen examined was extremely long, reaching beyond apex of abdomen.

Length, 2.64–3.28 mm, $\bar{x}$ = 2.86. Head, length 0.60–0.80 mm, $\bar{x}$ = 0.68; width 0.52–0.54 mm, $\bar{x}$ = 0.54; interocular space 0.36–0.40 mm, $\bar{x}$ = 0.38. Protergal length 0.26–0.34 mm, $\bar{x}$ = 30; humeral width 0.62–0.70 mm, $\bar{x}$ = 0.66. Antennal lengths I, 0.12–0.14 mm; II, 0.18–0.28; III, 0.16–0.24; IV, 0.30–0.38. Labial lengths I, 0.36–0.70 mm; II, 0.36–0.84; III, 0.38–1.00; IV, 0.36–0.70.

Second instar (in alcohol, n = 5).—Similar to 3rd instar, but head and pronotum nearly uniformly dusky.

Length, 1.88–2.10 mm, $\bar{x}$ = 1.95. Head, length 0.40–0.46 mm, $\bar{x}$ = 0.44; width 0.38–0.44 mm, $\bar{x}$ = 0.41; interocular space 0.30 mm. Protergal length 0.18–0.20 mm, $\bar{x}$ = 0.18; humeral width 0.42–0.52 mm, $\bar{x}$ = 0.46. Antennal lengths I, 0.08–0.12 mm; II, 0.14–0.16; III, 0.12–0.18; IV, 0.20–0.28. Labial lengths I, 0.26–0.36 mm; II, 0.28–0.40; III, 0.26–0.40; IV, 0.26–0.36.

First instar (in alcohol, n = 5).—Similar to 2nd instar but more elongate.

Length, 1.26–1.60 mm, $\bar{x}$ = 1.43. Head, length 0.34–0.40 mm, $\bar{x}$ = 0.37; width 0.30–0.32 mm, $\bar{x}$ = 0.31; interocular space 0.20–0.26 mm, $\bar{x}$ = 0.22. Protergal length 0.12–0.16 mm, $\bar{x}$ = 0.14; humeral width 0.34 mm. Antennal lengths I, 0.06–0.08 mm; II, 0.08–0.12; III, 0.08–0.12; IV, 0.20–0.24. Labial lengths I, 0.16–0.26 mm; II, 0.22–0.26; III, 0.22–0.30; IV, 0.20–0.28.

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